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THE ORIGIN OF SPECIES BY MUTATION*

By D. T. MacDougal

Admitting for the sake of the present discussion the validity of the results obtained by de Vries, the following general laws may be deduced from a consideration of the experimental observations recorded by him :

1. New elementary species may originate suddenly, without transition or intermediate forms between them and their immediate ancestors. The new species actually originate in the formation of the seeds, but are born, figuratively speaking, at the time of the germination of the seeds, and become recognizable in many instances as soon as the earlier leaves have unfolded.

2. The newly arisen species are constant from the moment of their origin, and a species is not to be considered as an arbitrary group but as consisting of a number of individuals conforming, within the limits of the fluctuating variations, to a sharply defined type.

3. The new forms arising in the experimental investigations were sufficiently divergent from the parents to be assigned specific rank, and might not be classed as varieties of the parent types.

4. The characters of the newly derived species show no resemblance to the individual variations exhibited by the parent type, being in fact qualitative rather than quantitative divergences. Special emphasis is to be laid upon this point, from which it would seem that species do not appear by gradual differentiations among plants growing wild in response to environmental stimuli,

*Continued from page 84.

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but originate suddenly without regard to their fitness for the conditions encountered.

5. As a further development of the last-named idea, the mutations by which new species arise are in themselves purposeless, and may differ from the parent in any particular, or, otherwise stated, mutation may take place in any given direction. Consequently, the greater number of the newly arisen types perish at once because of their pronounced unfitness for the conditions and competitions which they encounter, and do not reach a second generation. The surviving species must not only show a fitness for meeting the encroachments of existing forms, but must be anatomically and physiologically suitable for the environment. The number of mutants of any plant growing in a state of nature would usually be very much less than that obtained in the cultural operations described, by reason of the customary failure of the greater proportion of the crop of seeds to obtain germination conditions. It is of course possible that the exigencies of sudden erosions, or disturbances of the soil over small areas might occasionally furnish similar conditions to those under which *Onagra* mutated so abundantly.

6. The elementary species were found to arise in a number of individuals at the same time. The mutation from a parent type might occur in such manner that the new species would be formed in successive seasons in the same general manner.

7. Mutability occurs only at certain periods, and a species might continue existence indefinitely without giving rise to new forms.

In this last-named conclusion de Vries takes a position long held by Darwin that the variability of a species is independent of its environment and that the strengthening effect of use and weakening effect of disuse are in no wise to be considered as direct agents in the development of forms constituting new species.

The conceptions of de Vries as to the origin of species may be rightly understood only when his analysis of the character or consistency of a species is borne in mind. His interpretations of the facts lead him to the conclusion that the characters of an organism are made up of well-defined and separate units, or ele-

ments, and that these elements are associated in groups ; the same elements or groups of elements may, and supposedly do, recur in related species. The origin of a species by mutation would imply the substitution of a new elementary character, or quality, in the combinations, or groups, much after the same manner in which changes in the constitution of chemical bodies are effected.

It is these elementary units or characters which must be considered in the analysis of the qualities of a hybrid, and the proper application of the principles involved will, as de Vries asserts, afford an adequate explanation of the composite nature of hybrids. The forthcoming volume of this author upon the subject will be awaited with the greatest interest by all concerned with questions of descent and heredity.

From the reviews and discussions which have already been made of de Vries' papers it is to be seen that the greatest misunderstanding which may likely arise in the consideration of his results will be that founded on the error of confusing fluctuating variability and mutability. Individual variations, or fluctuating variations, may be caused by altered conditions of nutrition or other environmental factors, and when these conditions are applied and directed in gardening and agricultural operations they may give rise to the so-called improved races. Such variations are exhibited constantly, and in great number, and soon reach a maximum limit in any given direction, or in the development of any single quality, usually within a few generations, and the total departure from the original type is never sufficient to constitute an independent species, or true variety. Mutability on the other hand is a variation implying, and due to, the appearance of new qualities, or the disappearance of existing characters, or the rearrangement of elements, in such manner as to constitute new characters. Mutations are enormously rare in comparison with the fluctuating variations described above, and this very rarity has led to an underestimation of their value in the origin and development of species, according to de Vries' conclusions.

The writer is aware that the foregoing statements may be taken as a somewhat bold setting forth of the mutation theory, but still it is believed that the main contentions of de Vries are rightly

presented. Lack of space prevents a more critical and accurate delineation of the entire matter.

It is notable that a presentation of the importance of mutation or "heterogenesis" as a means of origin of new species has also been made recently by Korschinsky,* based upon historical evidence in which he presents a number of well-authenticated instances of mutations; other aspects of the subject have been brought out by Kölliker and Hartmann.

It will be of interest in this connection to cite a recent summary by von Wettstein of present knowledge of the method of origin of species as based upon information derived from the study of plants. This writer lays emphasis upon the fact that the significance of mutation must not be underestimated, and calls attention to the well-recognized fact that alterations in the elementary qualities of species have been demonstrated to take place only by hybridization and by heterogenesis (mutation). Other methods may exist but they lack the absolute proof which may be found in support of the two named. It is but fair to this writer to say, however, that he does not ascribe the origin of all species to any one cause, and that he lays great stress upon the fixation of adaptive characters, as well as upon hybridization and heterogenesis, as prominent among the factors to which new species owe their origin among plants in a state of nature. †

Since the above discussion was given to my colleagues before the weekly Botanical Convention, Professor de Vries has kindly sent me a supply of seeds of *Onagra biennis* (*Oenothera Lamarckiana*), the parent type used in his experimental cultures and also of five of the newly arisen species, viz: *O. brevistylis*, *O. gigas*, *O. lata*, *O. nanella* and *O. rubrinervis*. These were sown in the propagating houses of the New York Botanical Garden early in May and a fine crop of the different forms is already to be seen. These cultures will be most carefully observed, and the continued behavior of the parent type and derived forms noted, with respect

* Korschinsky, S. Heterogenesis und Evolution. Naturwiss. Wochenschrift, 14: 273. 1899. Also Flora, 89: 240–363. 1900.

† Wettstein, R. von. Der gegenwärtige Stand unserer Kenntnisse betreffend die Neubildung von Formen im Pflanzenreiche. Ber. Deut. Bot. Ges. 18: (184). 1900.

to further mutations, as well as to the constancy of their elementary characters.

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A KEY TO THE NORTH AMERICAN SPECIES OF RUSSULA.—I

By F. S. Earle

The Russulas are among our most abundant and attractive mushrooms. They are common everywhere in woodlands but seldom occur in open fields. The number of species is very great and many of them are conspicuous for their brilliant coloring. Bright reds, yellows, greens and purples are frequent among them, while other species appear in the less striking whites and browns. Many of the species are very hot and peppery to the taste, while a few are acrid or nauseous. This with their brilliant coloring has led to the belief that they are poisonous. In most cases the peppery taste disappears on cooking but in some the disagreeable flavors persist so as to render them unpalatable if not unwholesome. There is no evidence that any of the species are dangerously poisonous, like the deadly Amanitas, and it is probably prudent to eat of any of the species that are not unpalatable.

In studying the Russulas it is important to note carefully the characters of the lamellæ, whether equal or heterophyllous, forked or simple, whether the interspaces are veined or ribbed or smooth, and any changes in color either on maturity or when cut or injured. The taste and odor should also be carefully noted as also the color of the spores, whether white, bright yellow or ochraceous.

The first attempt at bringing together descriptions of our American species was by MacAdam (Journ. Myc. 5: 58–64, 135–141. 1889). This series of papers was unfortunately discontinued after twenty-five species had been described. McIlvaine and MacAdam (One Thousand American Fungi, 185–213. 1900) give descriptions of forty-five species. Peck in the Reports of the New York State Museum and in botanical journals has de-